SEPTEMBER, 1946

RADIO

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Design • Production • Operation

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RADIO

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Installing solder ring and side plates in the anode shell of a 4J51 magnetron at the Western Electric electronics shop.

ARTICLES

MISCELLANEOUS

RADIO Magazine (title registered U. S. Pat. Off.) is published monthly at Boston Post Road, Orange, Connecticut, by Radio Magazines, Inc. Executive and Editorial Offices at 342 Madison Avenue. New York 17, N. Y. Subscription rates—United States, U. S. Possessions & Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U.S.A. Entered as Second Class Matter May 10, 1945 at the Post Office at Orange, Conn., under the Act of March 3, 1879.

Transients

HI-FI AGAIN

★ Do listeners want high fidelity in sound reproduction? According to surveys made many years ago, they don't—that's why most receivers are operated with the tone controls adjusted to produce a "mellow" tone. When the reasons for this apparent preference for poor fidelity were investigated, objectionable noise at the higher frequencies was the principal gripe.

But these surveys were made long before the advent of f-m broadcasting. Pre-emphasis of higher frequencies, with de-emphasis at the receiver, along with the noise-reducing capabilities of frequency modulation, combine to make reception of higher frequencies not only palatable, but even enjoyable. When nice, big consoles providing a-m/f-m reception start rolling off the production lines in quantity, lots of people are going to start comparing the quality of reception from a-m and f-m stations. And, for discriminating listeners, the fidelity of a-m reception is going to suffer by comparison.

According to NBC, using f.m. with a deviation ratio of 5, noise is reduced over 18 db more by f.m. than by a.m. When de-emphasis is employed in both a-m and f-m systems, the latter is about 7 db better. From this comparison, it seems worthwhile to consider using pre-emphasis at a-m transmitters in order to make less objectionable the fluctuating noise and tube hiss occurring in this region. Despite the fact that channel width limitations preclude broadcasting with amplitude modulation over as wide a range of frequencies as is possible with frequency modulation, the fact that it is still necessary to use a tone control to attenuate high-frequency noise proves that pre-emphasis should improve high-frequency signal response.

Of course, the lower frequencies are likewise essential to high-fidelity reception. And because the present crop of f-m receivers consists largely of table model receivers incapable of good low-frequency reproduction, a great many listeners have yet to learn just how good real high fidelity reception can be.

MULTIPLEX BROADCASTING

★ The International Telephone and Telegraph Corporation recently gave a very successful demonstration of multiplex broadcasting, using pulse-time modulation. Eight different types of broadcast service were transmitted simultaneously from a single transmitter operating on but one carrier frequency, 930 mc. Types of service transmitted were, stock ticker, Muzak, a-m and f-m music rebroadcast, news broadcast, recordings, teletype, and facsimile. The wide variety of programs was chosen to demonstrate the adaptability of the multiplex system. Music transmission was of high quality, covering an audio range of 9,000 cycles, which could be increased if desired.

Although purely an experimental demonstration of the method, it is apparent that this system of multiplex broadcasting has interesting possibilities for the future. The demand for broadcasting time within a specific period in the early evening may be satisfied by equipping several stations in metropolitan areas for simultaneous broadcasting over several channels without increasing the number of frequency assignments. This would afford the listener a wider choice than is now possible and would at the same time increase greatly the revenue which would accrue to the broadcaster.

The types of service chosen for the demonstration indicate how greater expansion of broadcast facilities can be realized. Undoubtedly there are a great many offices which would subscribe to stock ticker, teletype, facsimile, and similar services, if made available at a reasonable price. This would serve to increase the broadcast station's revenue during the day, when the number of listeners in their homes is fewer, and consequently broadcasting time is cheaper.

While the present system requires a fairly wide band, about 6 mc, this can be halved by using single sideband transmission, and still further reduced by using a narrower guard band between programs. Under the present system, there is a five-microsecond space between each channel, and the pulse duration is one-half microsecond. Stations are selected at the receiver by means of a delay line, replacing a special cathode-ray tube used in original experimental multiplex pulse time modulation broadcasting demonstrated about a year ago.

PATENTS

★ One would think that the great increase in research in radio engineering during the past few years would result in a corresponding growth in the number of patents issued. This is not the case. Patents granted during the month of August, 1936 totalled substantially the same as those issued during the corresponding month of this year. Undoubtedly the quantity of applications for patents has increased greatly, but the number of rejections appears to have grown proportionately. This would seem logical because most of the more obvious ideas have already been patented, and it becomes more and more difficult to find something new. Furthermore, the time and work required at the patent office to make searches must likewise have increased tremendously.

As we get into greater production of apparatus which incorporates new features, we may expect these to stimulate still further thought along similar lines, which will inevitably be reflected in an increased number of patent applications.—*J. H. P.*

TECHNICANA

B.B.C. T-V WAVEFORM

★ Specifications of the B.B.C. television waveform, with revisions and minor corrections to bring the material up to date, are presented in the June 1946 issue of *Electronic Engineering*.

The transmitted waveform is illustrated in *Fig. 1* and the method of interlacing in *Fig. 2*.

Twenty-five complete pictures are transmitted per second, each of 405 total lines, interlaced so that the frame and flicker frequency is 50 cps. The transmitter radiates sidebands to 2.5 mc on either side of carrier frequency. Thus the line frequency is 10,125 lines per second, and the frame frequency is 50 frames per second, with each frame composed of 202.5 lines.

The interval between the vision signals of successive lines is 16.5% of the total line period (1/10,125 sec.). The first 0.5% of this interval corresponds in intensity to black and separates vision signals from the beginning of the line-synchronizing signal, and the final 5% separates the end of the line-synchronizing signal from successive vision signals.

Between frames is a 14-line interval, leaving 188.5 active lines per frame, or 377 active lines per complete picture. The d-c component is transmitted as amplitude modulation. An increase in carrier represents an increase in picture brightness, and vision signals occupy values between 30% and 100% of peak carrier. Signals below 30% of peak carrier represent synchronizing signals and extend to effective zero carrier.

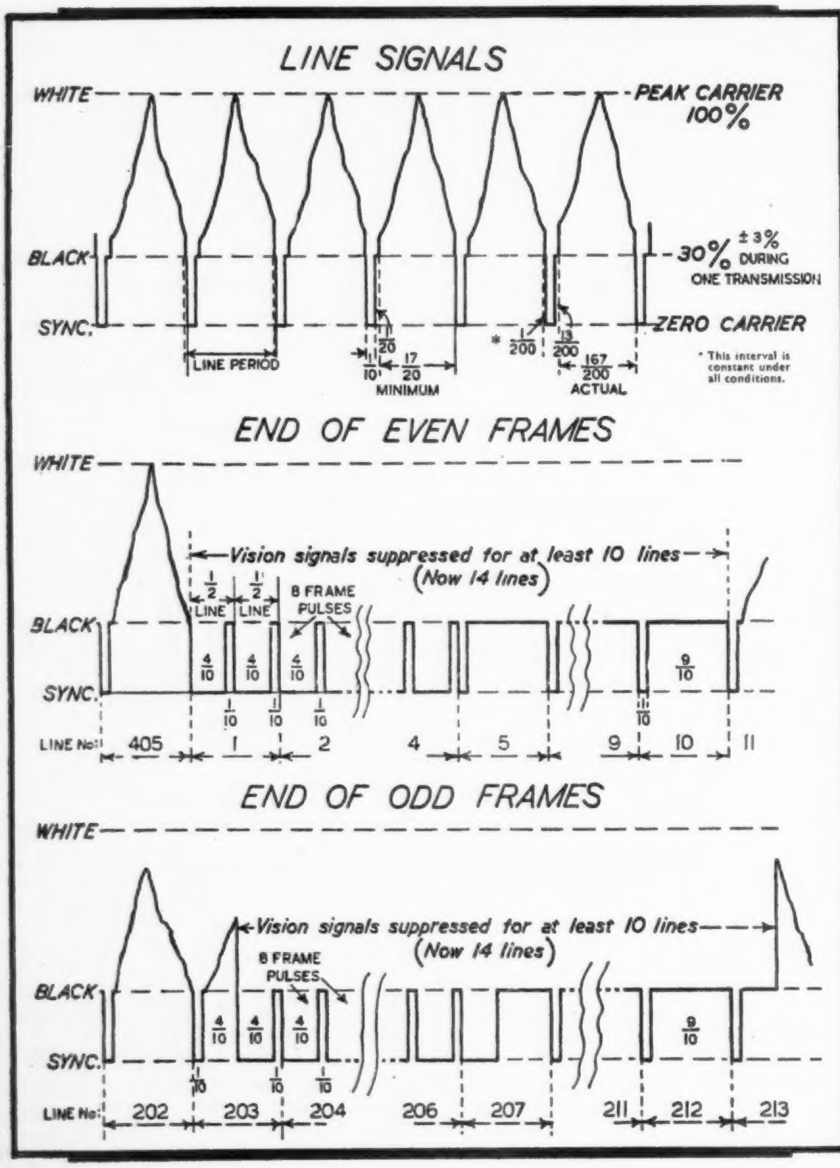

Figure 1

Line synchronizing signals are of one-tenth of a line duration and are followed by one-twentieth of a line of black (30% peak). The frame-synchronizing signals comprise a train of two pulses per line, each occupying four-tenths of a line and having one-tenth of a line interval of black signal between them. At the end of even numbers of frames the first frame pulse starts, coincident with what would have been a line signal; and at the end of odd numbers of frames the first pulse starts half a line after the preceding line signal. Each frame signal consists of eight pulses, occupying four lines. During the rest of the intervals between frames, normal line-synchronizing signals will be transmitted, with black signals during the remaining nine-tenths of the line.

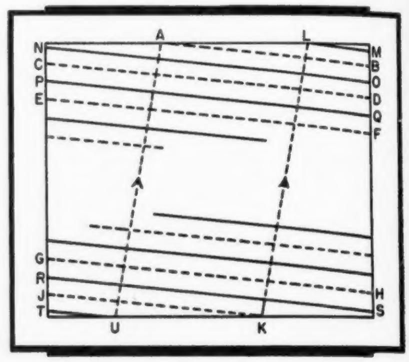

Figure 2

It will be noted that throughout the interval between frames (as during the whole transmission) the carrier falls from 30% to zero regularly at line frequency and in phase with the beginning of the normal line-synchronizing pulses.

The method of interlacing is shown in *Fig. 2*. Starting at *A*, not necessarily at the beginning of the line, the spot completes the line *AB*, returns to the left and traverses line *CD*, then *EF*, etc. At the bottom of the frame the spot travels along line *GH*, and then starts at *J* and travels to *K*. At this point the fly-back of the frame motion begins and returns the spot to *L* at the top of the frame.

A complete frame scan has now been made since leaving *A*, so that 202½ lines have been completed, and the point *L* is half a line away from *A*. The downward frame motion now starts again, causing the spot to travel along *LM*, completing a single-line motion

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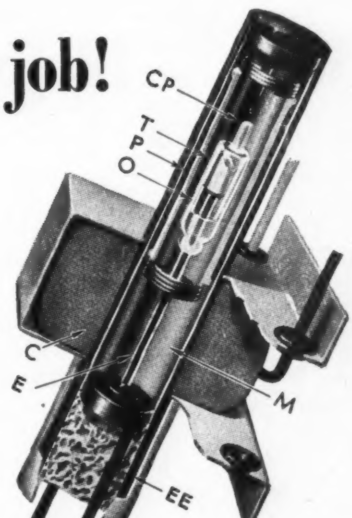

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JKLM. The spot then returns to the left and traces out line *NO*, which, because of *L* being half a line ahead of *A*, will lie between lines *AB* and *CD*.

The complete picture is thus scanned in two frames, but as each frame contains an integral number of lines, plus a half, the two frames interlace. Line frequency and frame frequency are locked to the 50 cps supply.

DIELECTRIC LOSS MEASUREMENTS

★ Design of measuring equipment and suitable operating techniques for low-loss samples such as polystyrene, are discussed in an article entitled "A Microwave Dielectric Loss Measuring Technique" by William R. MacLean in the *Journal of Applied Physics* for July, 1946. Dielectric loss is measured by Q determinations of a cavity resonator using a double-sample technique.

Measurement of the dielectric constant ϵ and the loss factor *d* for small values of *d* has previously involved a number of difficulties:

1) Resistance losses at joints, particularly at sliding joints.

2) With a relatively high metal loss present, a small quantity must be measured in conjunction with a larger parasitic one.

3) The metal loss cannot be accurately calculated because of variability of the so-called roughness factor.

4) Measurement of the metal loss becomes of doubtful value when using a shifted frequency, with altered geometry inside the cavity.

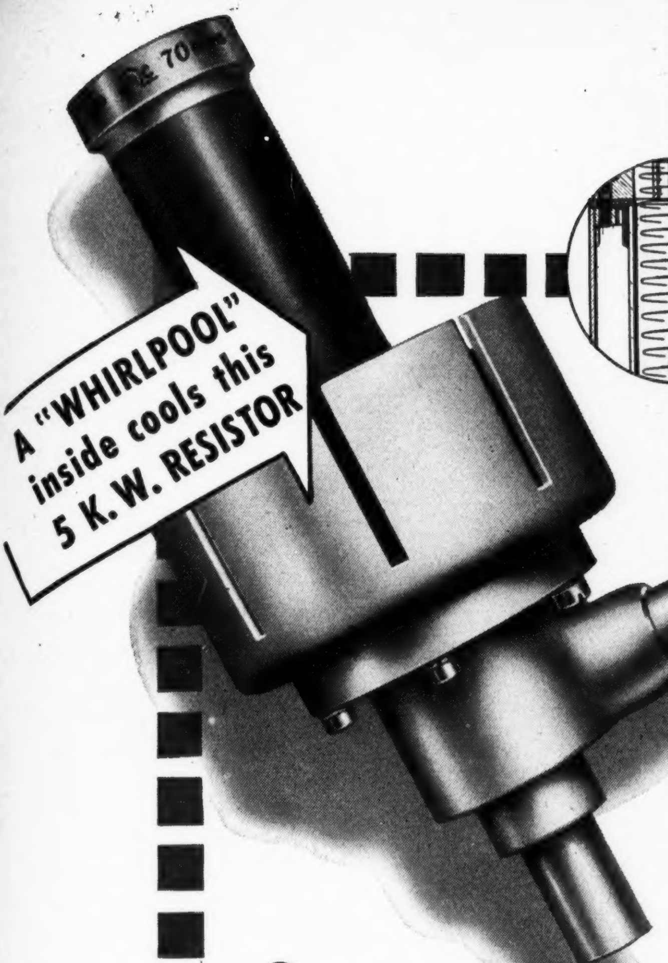
5) Correction may be necessary for a certain amount of loss from coupling into and out of the resonator.

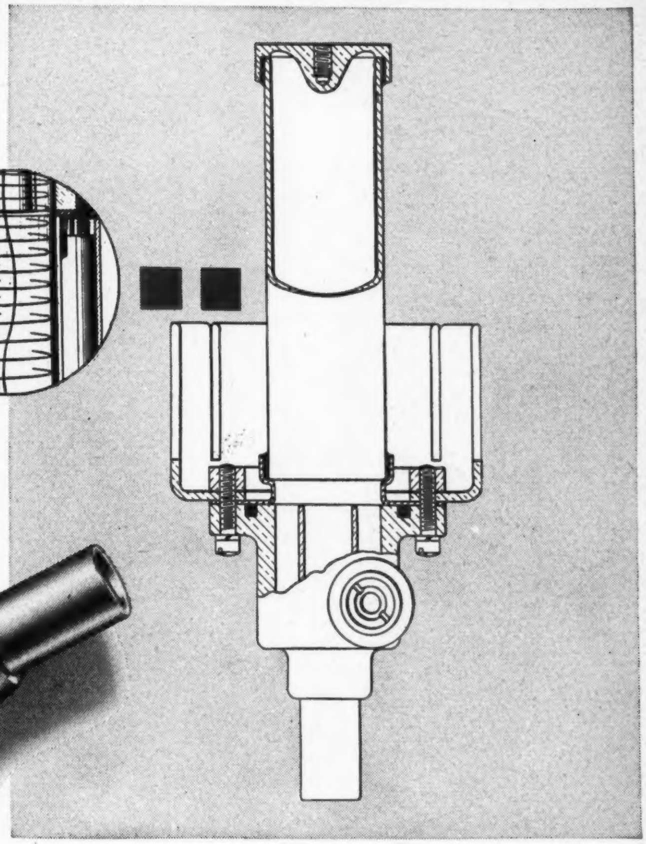
6) Resonator Q's are high, and when sliding plugs are used, movements of only a few mils are involved in determination of half-power points.

7) Crystals are customarily calibrated at much lower frequencies, or a square law is assumed, placing its half-power point in question.

Mr. MacLean has therefore undertaken investigation of small-loss measurement, and his technique is restricted to this field. A preliminary approximate determination of ϵ is made, which is checked in the final measurement, and a value determined for the small loss factor *d*.

The noted difficulties have been overcome by use of a cylindrical resonator utilizing a transverse electric mode involving no current flow across the cracks. The samples are placed inside the resonator as a dielectric core and the field is confined almost exclusively to the dielectric. This eliminates side-





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wall loss from the practical standpoint, and the losses on the end pieces can be made negligible by using a long sample and resonator.

Actual losses on the end pieces are eliminated by the technique of measurement with first one, and then two identical samples. Any loss due to the input and output coupling is also eliminated at the same time.

Detuning of the resonator for the Q measurements is effected by pushing a small metal rod into the center-bored samples as required. A millimeter scale is provided. This detuning effect is so small that a large movement of the rod is obtained, no matter how high the encountered Q. The method includes a determination of the half-power point of the crystal at frequency of operation.

Two small loops are used for the driving oscillator and detecting crystal. These are removable with the top cover, for convenience of insertion of samples; a convenient slotted spider with thumbscrews makes for rapid manipulation.

Detailed techniques and theory of operation are presented by the author. In brief, the Q of the resonator is determined with one, and then with two samples. If W = stored energy, and D = power loss, then

$$d = 1/Q = D/\omega W$$

and with two sources of loss, the damping factor is considered as composed of d_1 observed with one sample, plus d_2 observed with two samples; d_1 consists of several parts, of which d_0 is defined as the dielectric loss. It is then developed that

$$d_0 = 2d_2 - d_1$$

subject to a correction factor derived with the aid of Bessel integrals. Application of the correction factor is made simple by means of plots presented in convenient form by the author.

A considerable portion of the article is also concerned with the design factors of equipment for use in various loss ranges, for which reference should be made to the original paper.

SWEEP TRACE ROTATION

★ L. Bainbridge-Bell, in a communication to the editors of *Electronic Engineering*, June 1946, points out that elaborate techniques are occasionally used to determine the sense of rotation of a circular cathode ray sweep trace when a glance will do the trick.

For this purpose, the observer looks *quickly* from *left to right* across the screen, whereupon cusps are seen. If these cusps point *upward* the movement of the spot is clockwise; if the cusps point *downward*, the spot is moving counter-clockwise.

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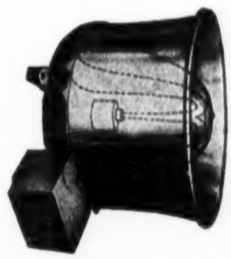

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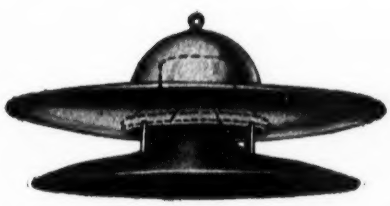

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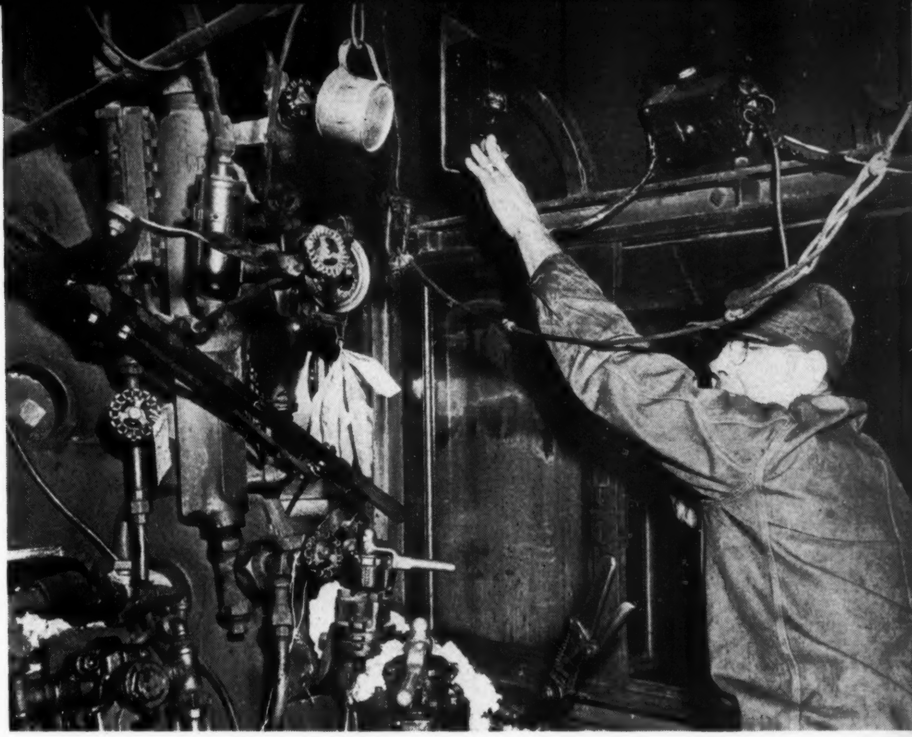


Fig. 1. Operating position of Bendix railroad radio.

Design and Application of SQUELCH CIRCUITS

FREDERICK DELANOY

Survey of squelch circuits used by receiver engineers, with representative applications

Squelch circuits are not particularly new. In tracing their development through the years, one finds all-but-lost references to balanced crystal circuits used in the pre-tube days to combat atmospherics. It is perhaps stretching a definition to classify these as squelch circuits since they were designed to combat noise within as well as between channels. At any rate, these early circuits are closely related to squelch circuits and are direct forebears of present-day "hole-puncher" circuits, which are regarded as a relatively new discovery in some circles.

Interchannel noise is a problem in any sensitive receiver using avc, since the gain of the receiver rises in the absence of a carrier. The problem becomes aggravated in commercial and public-service applications, where personal efficiency of operators is frequently impaired by long-continued acoustic irritation. Suppression of interchannel noise is likewise advantageous in the case of domestic receivers, since the receiver then possesses greater sales appeal.

Subdivision of Circuits

A broad general division of squelch circuits may be made to include those which are electro-mechanically actuated, and those which are all-electronic. The

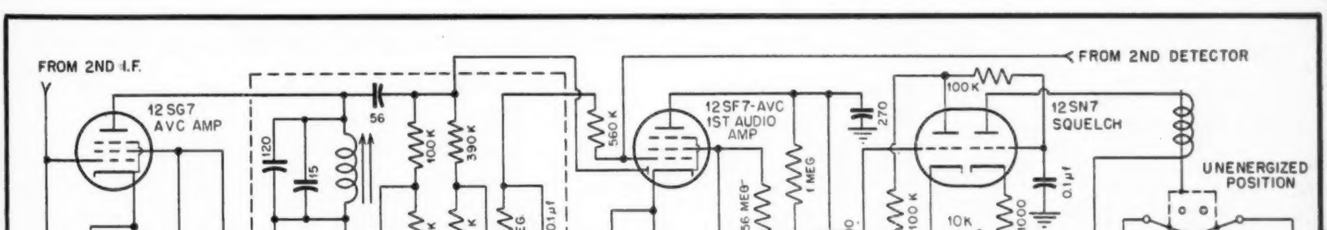


Fig. 3. Schematic diagram of Bendix a-m squelch circuit, using relay.

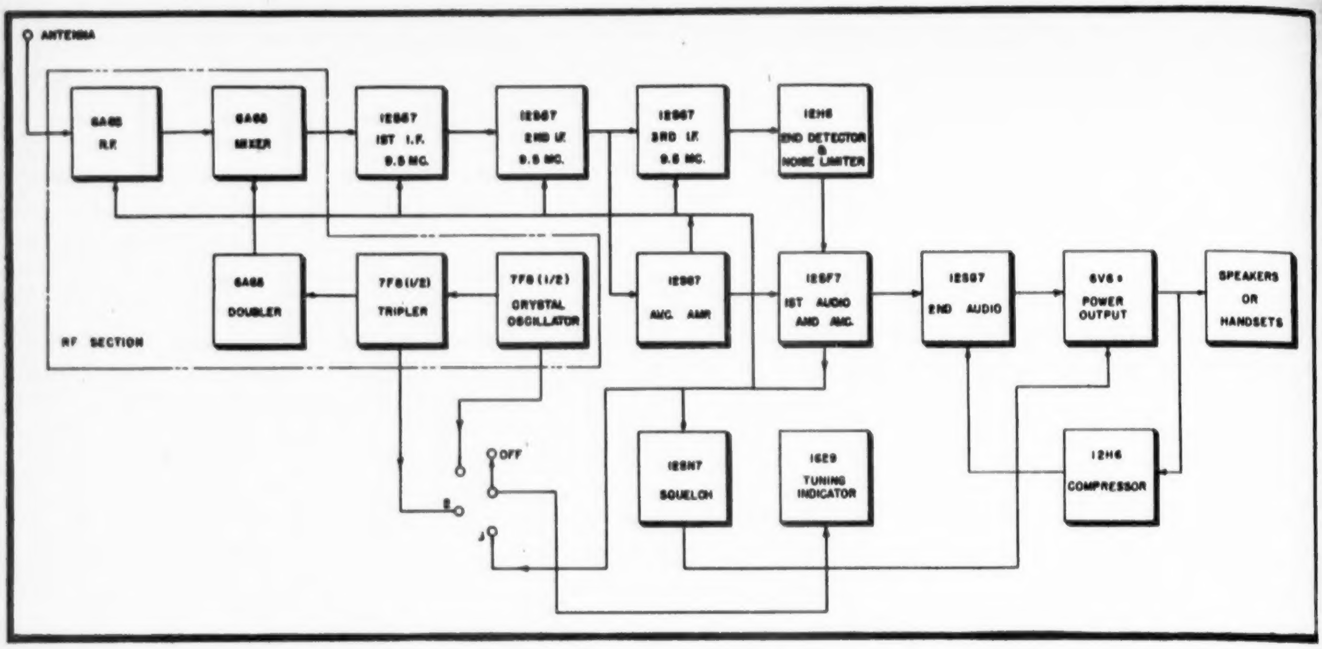
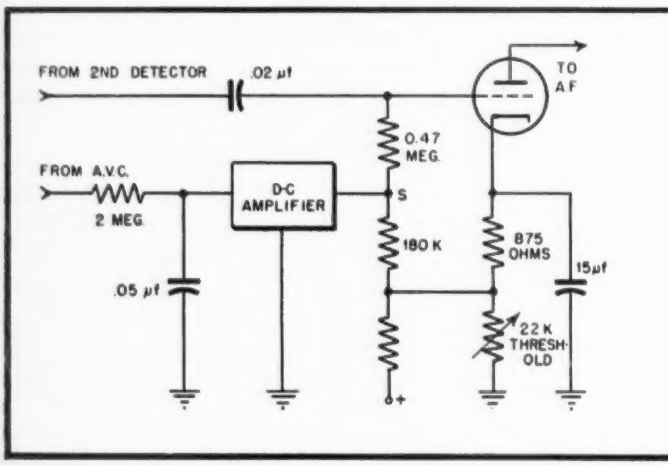


Fig. 2. Block diagram of railroad receiver, showing location of squelch circuit.



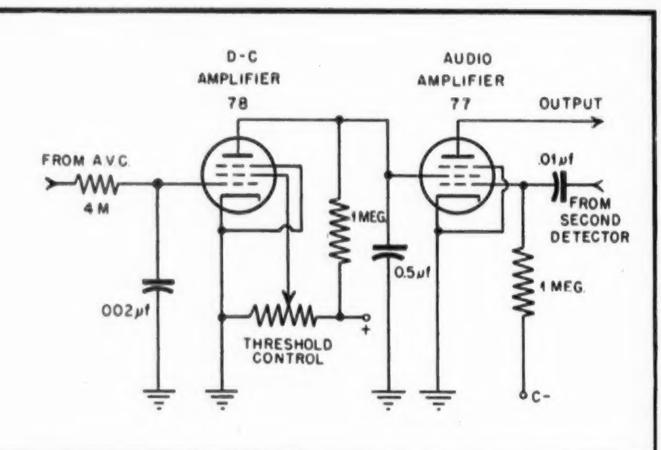
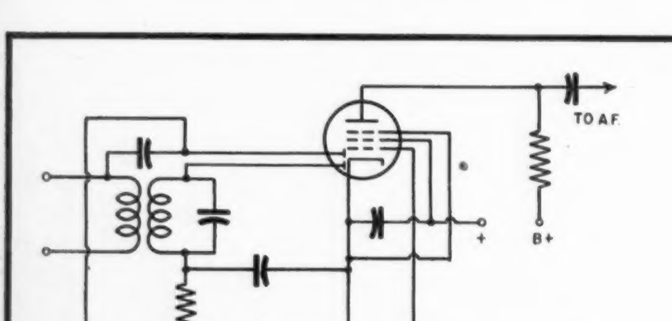


Fig. 5. (left) Typical all-electronic squelch circuit, using d-c amplifier. Fig. 6. (right) Squelch circuit used in Philco receivers.



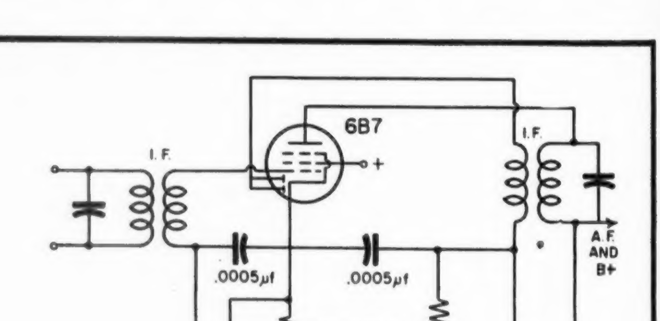


Fig. 7. (left) One-tube squelch circuit used in Australian receivers. Fig. 8. (right) Emerson design of single-tube squelch circuit.

first group of circuits is the outgrowth of an early patent issued to the Marconi Co., and these find extensive application at the present time. These electro-mechanical circuits utilize a sensitive relay in the plate circuit of an a-v-c tube. The relay threshold is then adjusted to disable the receiver at the point where the input signal level becomes so low that background noise becomes objectionable.

An application of the electro-mechanical squelch system is shown in *Fig. 1,* which illustrates the operating position of the Bendix a-m railroad radio system for two-way voice communication between mobile and fixed stations. The receiver block diagram is seen in *Fig. 2,* indicating the position of the squelch circuit with respect to the a-v-c system.

A schematic diagram of the squelch circuit appears in *Fig. 3.* When a signal of sufficient amplitude appears in the antenna, the output from the second i-f amplifier becomes amplified successively in the a-v-c amplifier and in the d-c coupled squelch amplifier. Increase of plate current in the d-c amplifier tube closes the squelch relay, completing the cathode circuit of the 6V6 power amplifier tubes indicated in *Fig. 2.*

F-M Application

Electro-mechanical squelch systems are likewise applicable to f-m receivers. When the circuit of *Fig. 2* is converted for f-m operation, the last i-f stage is tuned to twice the i-f frequency (19 mc) and operates as a combination doubler-limiter, yet contributes some gain. The squelch relay operates as shown in *Fig. 4,* and is energized by output from a d-c amplifier as before. The d-c amplifier is actuated by rectified voltage obtained from the doubler grid. The squelch circuit becomes energized with input signals of one microvolt or less, and is provided with the variable 10k resistance for purposes of threshold control.

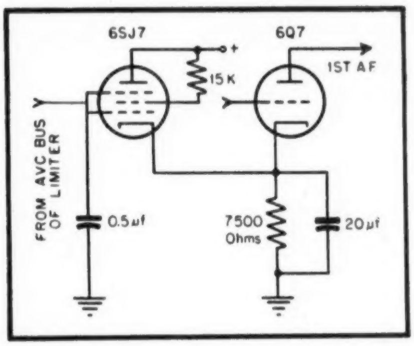
Overall sensitivity of this receiver is better than a microvolt, as for the a-m version. Tests conducted on moving trains show the squelch relay to be entirely satisfactory and reliable.

All-Electronic Systems

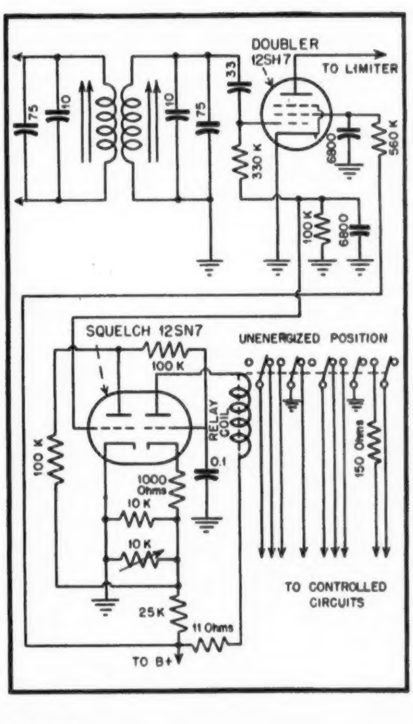
An electronically operated squelch circuit is shown in *Fig. 5.* The triode serves as both an a-f amplifier stage and as a squelch tube. Between channels the a-v-c bias drops to zero and the d-c amplifier draws increased plate current, raising the grid-cathode bias of the squelch tube beyond cut-off. The d-c amplifier thus constitutes in effect a variable resistance between point *S* and ground. The integrating circuit to the d-c amplifier provides sufficient time delay that the squelch circuit does not respond to bursts of static.

The inevitable result of using a squelch circuit of either type is that the ultimate sensitivity of the receiver is impaired. Signals which would be distinguishable in the vicinity of the noise level are made inaudible, and this must be regarded as the price which is paid for interchannel muting. A sensitivity control is frequently provided, which allows the muting threshold to be lowered during periods of low prevailing noise level. This control allows the operator to realize maximum sensitivity of the receiver when required.

A commercially popular squelch circuit (Philco) is shown in *Fig. 6.* In this version, the screen-grid voltage is varied instead of the control-grid voltage. Its basic mode of operation is the same as that of *Fig. 5*: between channels the a-v-c bias voltage approaches zero, with



(Above) Cathode-coupled squelch circuit for f-m receiver, which is finding popularity in Australia. This circuit has also been published in the U. S. magazine "Science". With no signal from the limiter, the interstation-noise-suppressor tube biases the first a-f stage to cut-off. With signal, the 6SJ7 draws less current through the 7500-ohm resistor, and the 6Q7 is brought out of cut-off. (Below) Fig. 4. Schematic diagram of f-m squelch circuit (modification of Fig. 3)



the result that the d-c amplifier tube draws a large plate current. This brings the top of the 1-meg. coupling resistance nearer to ground potential and places the 77 out of its operating range.

When a carrier is tuned in with an amplitude greater than threshold value, the plate resistance of the 78 is increased to the point that the 1-meg. coupling resistance maintains an operating voltage on the 77 screen grid, and the audio amplifier functions once more.

Dr. Terman has noted an interesting modification of squelch circuit design in his "Radio Engineers' Handbook" to make reception of weak signals possible. He suggests energizing the d-c amplifier from a very selective branch of the i.f. and a second diode. This improves the signal-noise ratio in the squelch circuit which makes it possible to set the threshold lower than otherwise. Dr. Terman states that the threshold can be set so low that the signal is down in the noise and almost unintelligble.

Squelch circuits have acquired many equivalent names over their extended period of development. The Bell circuits are termed Codan, derived from the words Carrier-Operated Device, Anti-Noise. Other terms are QAVC for quiet automatic-volume control, or simply Q circuits; NSC for noise-suppression circuits, interstation muting circuits, muting systems, and sensitivity control circuits.

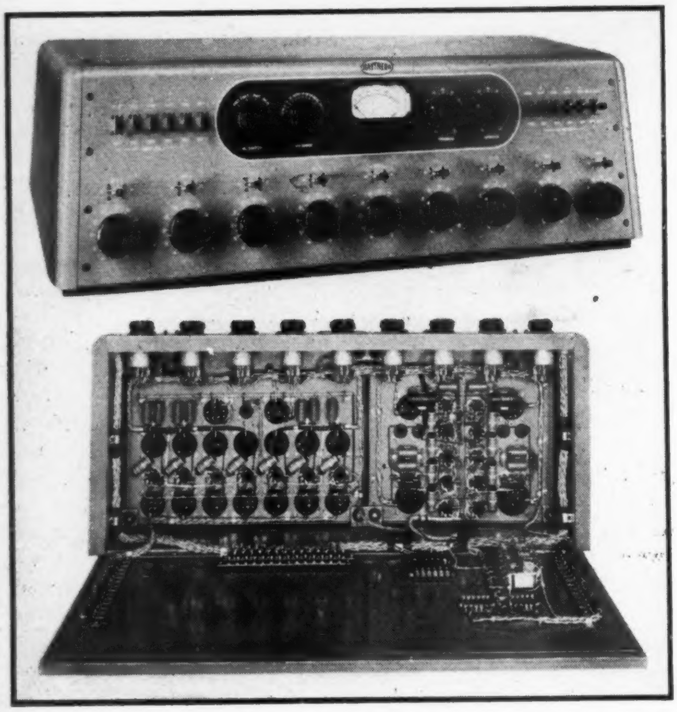
One-Tube Squelch

Squelch circuits have received attention abroad, and Australian Patent No. 19,886 describes an interesting one-tube circuit. A circuit based upon the patent and reported upon by S. J. Watson in the *A.W.A. Technical Review* is shown in *Fig. 7.* Operation of the circuit is based upon the small gain obtained in a resistance-coupled pentode amplifier when the control-grid bias is either too large or too small. Bias for the control grid is developed across R_1 and R_2, and the muting control is set to reduce the gain approximately 20 db as a result of insufficient negative bias.

With a carrier voltage applied to the a-v-c diode, the a-v-c bias makes the grid more negative, bringing the operating point down the load line past the knees of the plate characteristics and thus affording full gain of the tube. As the carrier amplitude continues to rise, the grid bias becomes sufficiently negative that the gain again falls.

This reduction of gain takes place more rapidly for low values of grid bias than for high values, using a 6G8G tube with the following parameters: Mu = 900, G_m = 1100 µmhos, cutoff at −35v., 250 v. plate, 100 v. screen, −3 v. control grid, 6.3 v. heater.

[*Continued on page 29*]



Modern Studio

Leo G. Killian, Paul L. Tourney, and John W. Hooper

Raytheon Mfg. Co.

Fig. 1. Front and under-chassis views of studio console, showing controls for two studio and control-room announce-microphones two transcription turntables and nine incoming lines. Under-chassis view shows wiring of seven preamps, monitoring, and program amplifiers.

As a result of increased activity in modern broadcasting techniques due to f.m. and the need for higher quality transmission, more interest is being centered upon improved types of speech input equipment.

Among important "links" affecting the overall performance of a broadcast station are units of the speech input type generally referred to as studio speech-input consoles and remote pickup amplifiers. A unit of each type in this class is considered in this article.

Two-Studio Console

Increasing demand for higher quality audio transmission requires apparatus having a wide response range. In addition, such equipment must include a means for gauging the true quality of transmitted programs, especially in frequency-modulated radio stations. This studio console has many new and useful features and provides a modern, compact, flexible, wide range speech input system adaptable for use in both a-m and f-m broadcasting.

The equipment comprises all the necessary control and monitoring circuits to fit the needs of modern broadcast station requirements. In a typical installation, for example, such a unit has facilities to handle two studios, a control-room announce microphone, two transcription turntables and nine incoming lines. Other arrangements are of course possible and provision is made for the simultaneous auditioning and broadcasting from any combination of the studios, turntables or remote lines.

Circuit Arrangement

A single all-metal console is used as a housing for the amplifying and control equipment. *Fig. 1* shows the arrangement of the front panel controls and chassis wiring. The dual power supply for the speech-input console is placed in a separate cabinet and mounting can be effected on desk, wall or relay rack. Functions and arrangement of the various circuits are shown in the block diagram, *Fig. 2*.

The console is made up of seven preamplifiers, one program amplifier, and one monitoring amplifier. A nine-position mixer system is utilized to provide complete control of the seven preamplifiers as well as two remote circuits. Three-position lever-action keys are used in the output of each mixer so that it may be switched to the input of the program amplifier for broadcasting use or to the monitor amplifier for auditioning purposes. The five microphone switches are interlocked to three loudspeaker cut-off relays. This prevents operation of speaker *B*, *C*, or *D* in any studio where there is a live microphone, but facilitates cueing by allowing the performers to hear the close of the program preceding their own. Preamplifiers Nos. 6 and 7 are normally used as transcription turntable input amplifiers; however, they may be employed for microphone input use if desired.

The program amplifier provides a high-gain, low-distortion, low-noise level amplifier for feeding the transmission line to the transmitter location point. The monitor amplifier has a maximum output of approximately 8 watts. With the monitor input switch connected to the program output line through a pad, the monitor amplifier feeds loudspeaker outlets *A*, *B*, *C*, and *D*. By connecting the monitor switch to the monitor section of the input switch-

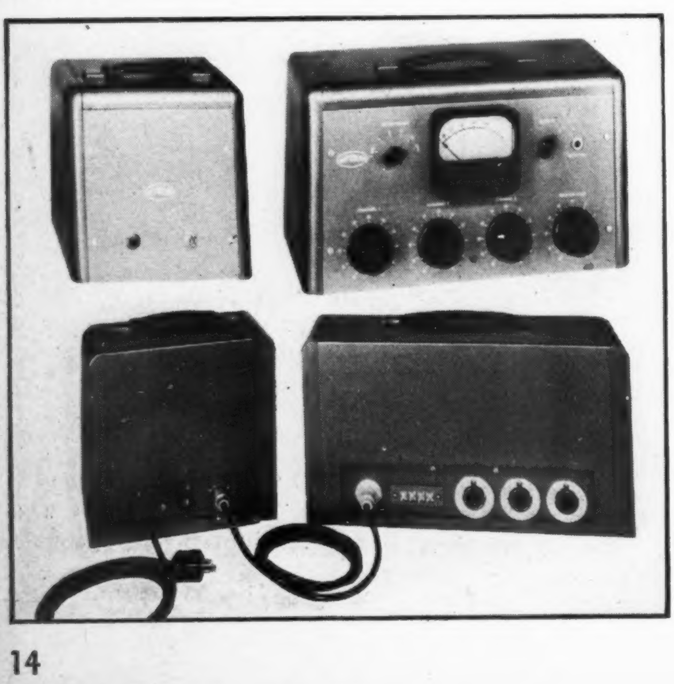


Fig. 4. Front and rear views of the three - channel remote amplifier and power supply. Connections for three input channels and output lines shown.

& Portable Speech Input Equipment

Technical details for a well-designed studio console and a three-channel remote amplifier are presented

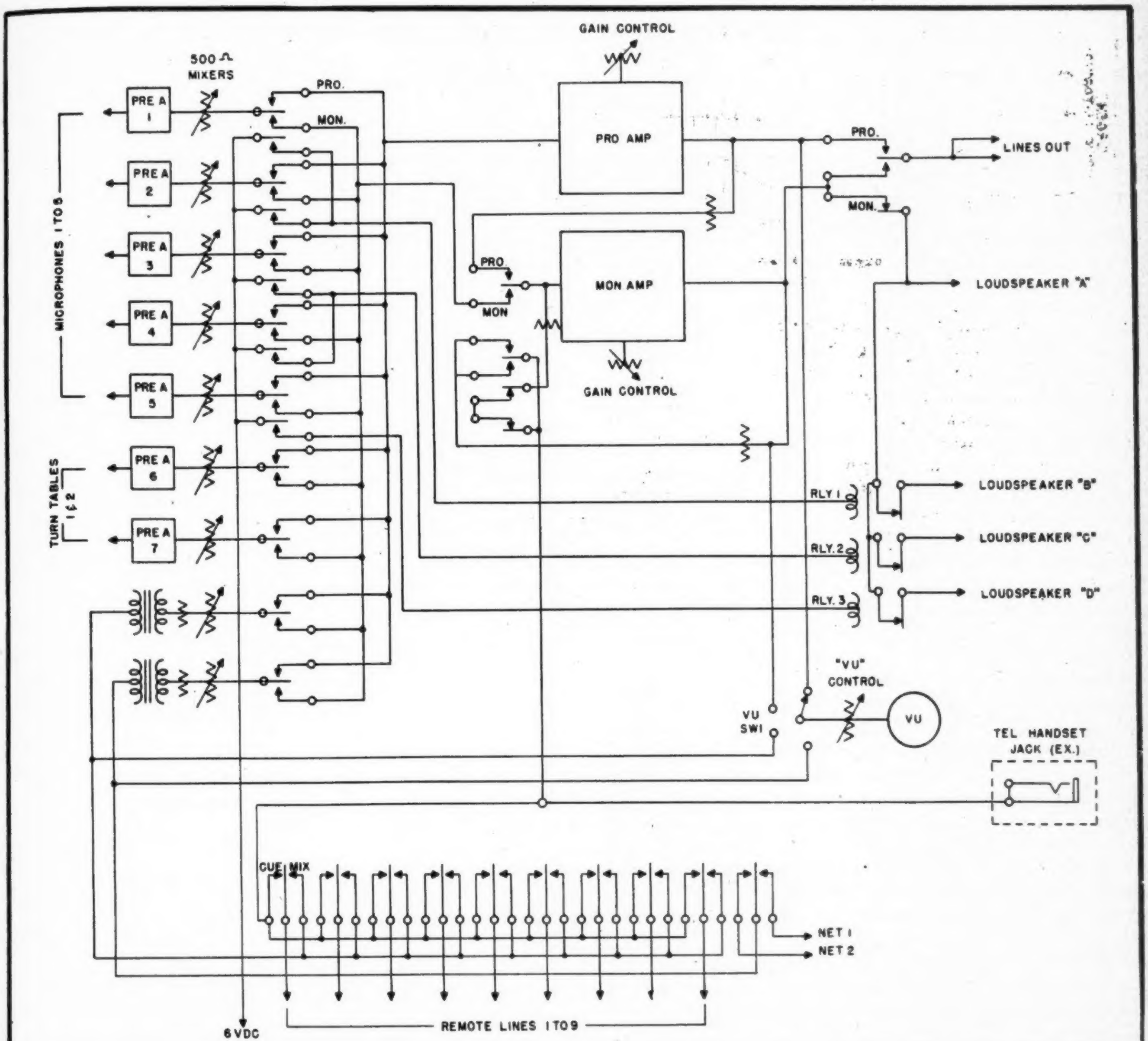


Fig. 2. Block diagram of the studio console, showing functions of the various flip switches.

ing keys the amplifier operates as an auditioning amplifier. In an emergency the monitor amplifier can be used as a program amplifier. An amplifier output switching key connects either the program or monitor amplifier to the "Lines Out". Loudspeaker circuits are also disconnected when this key is operated in the "Monitor" position. In the center position both amplifier outputs are disconnected from the line circuits but the loudspeakers are in normal operation.

Nine incoming lines can be switched to either a mixing position or to a cue position (*see block diagram*). A cue from the output of the monitor amplifier may be fed to any one incoming line when the "Program-Monitor" switch is in either the program or monitor position. When the "Program-Monitor" switch is in the center position the cue is disconnected and the monitor amplifier can be used for "listening" to any remote line point while another remote line or studio is "On the Air". Terminals are provided for the connec-

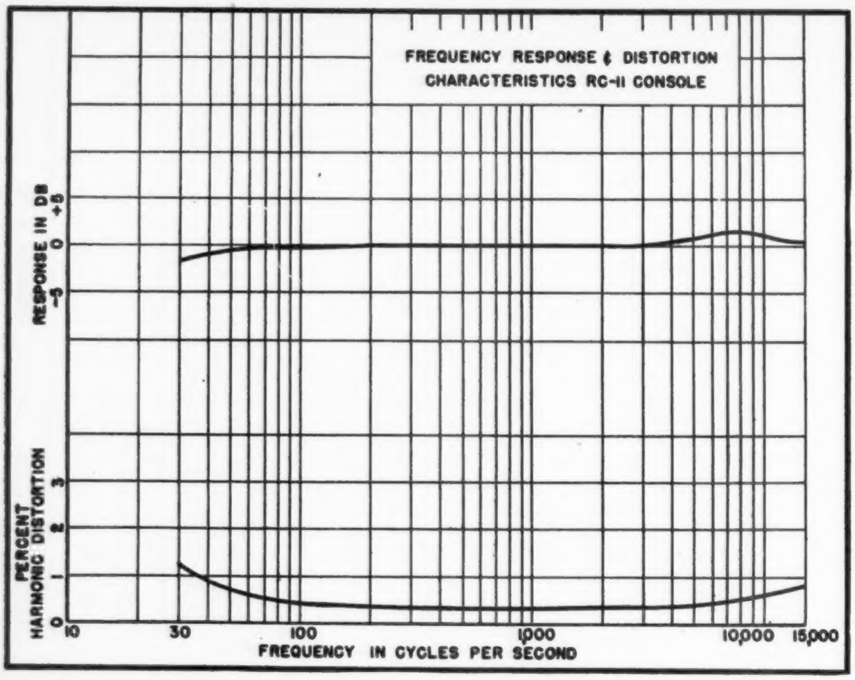


Fig. 3. Typical frequency response and distortion curves taken on a production sample of the console

tion of a telephone handset jack which enables the operator, through the use of a sound powered handset, to talk or listen to any remote point without disturbing his normal studio operation. Talkback to adjacent studios is served through the monitor amplifier and switching facilities. If desired, headsets may be connected to the program, monitor, or remote lines at easily accessible terminal board termination points located on the inside base of the console. Repeater transformers are installed in both the remote line and network mixing positions.

An illuminated VU meter indicates the level at the output of the program amplifier and the monitoring amplifier. It also shows the level at the inputs of the two remote line mixers. Meter switching in these circuits is accomplished by the use of the VU switch located on the left side of the meter. The range of the meter may be extended by the meter multiplier "VU range" switch which is adjacent to the meter. Twelve steps of 2 db per step are provided for this purpose and extend the range to +24 db. An off position is provided on the meter multiplier switch to protect the instrument when making circuit adjustments.

Power Supply

A dual wall or relay rack mount power supply furnishes power for the operation of the console. The power supply is made up of two separate complete units. One supply energizes the program amplifier and the other is for the monitor amplifier. Power for the pre-amplifiers is obtained from either of the two supplies by means of a rotary switch located on the supply front panel. A d-c supply operates the three 6-volt speaker relays which are mounted on the base of the console. Up to three additional relays may be energized from the supply if desired.

Specifications and Electrical Characteristics

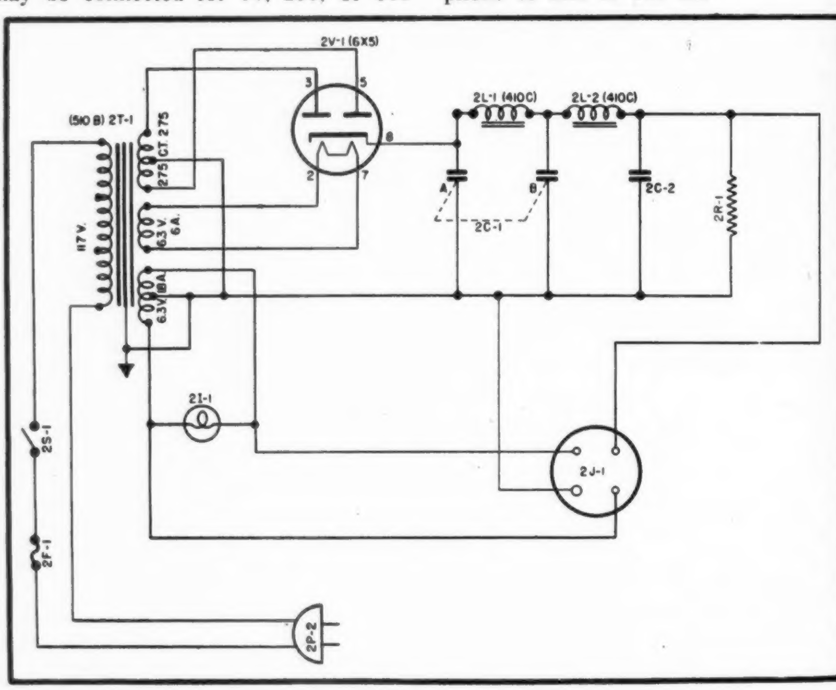
The pre-amplifier input impedance may be connected for 50, 250, or 500 ohms. The remote line input impedance is 600 ohms or 150 ohms. Each pre-amplifier consists of a single 6J7 type tube, transformer-coupled to the mixer system.

The tube line-up of the program and monitor amplifiers is identical. Each amplifier consists of two 6J7 resistance-coupled stages and one 6SN7GT resistance-coupled driver stage for the push-pull 6F6 output tubes. The output impedance of each amplifier is 600 ohms.

Monitor and line amplifier application requires excellent response over a wide range of frequencies. It is most desirable to obtain a response curve which is flat over a wide range and which contains no positive slopes within or near the range of frequencies normally supplied to the amplifier. This last characteristic helps improve transient response. The use of feedback aids in this respect and helps reduce hum and noise as well.

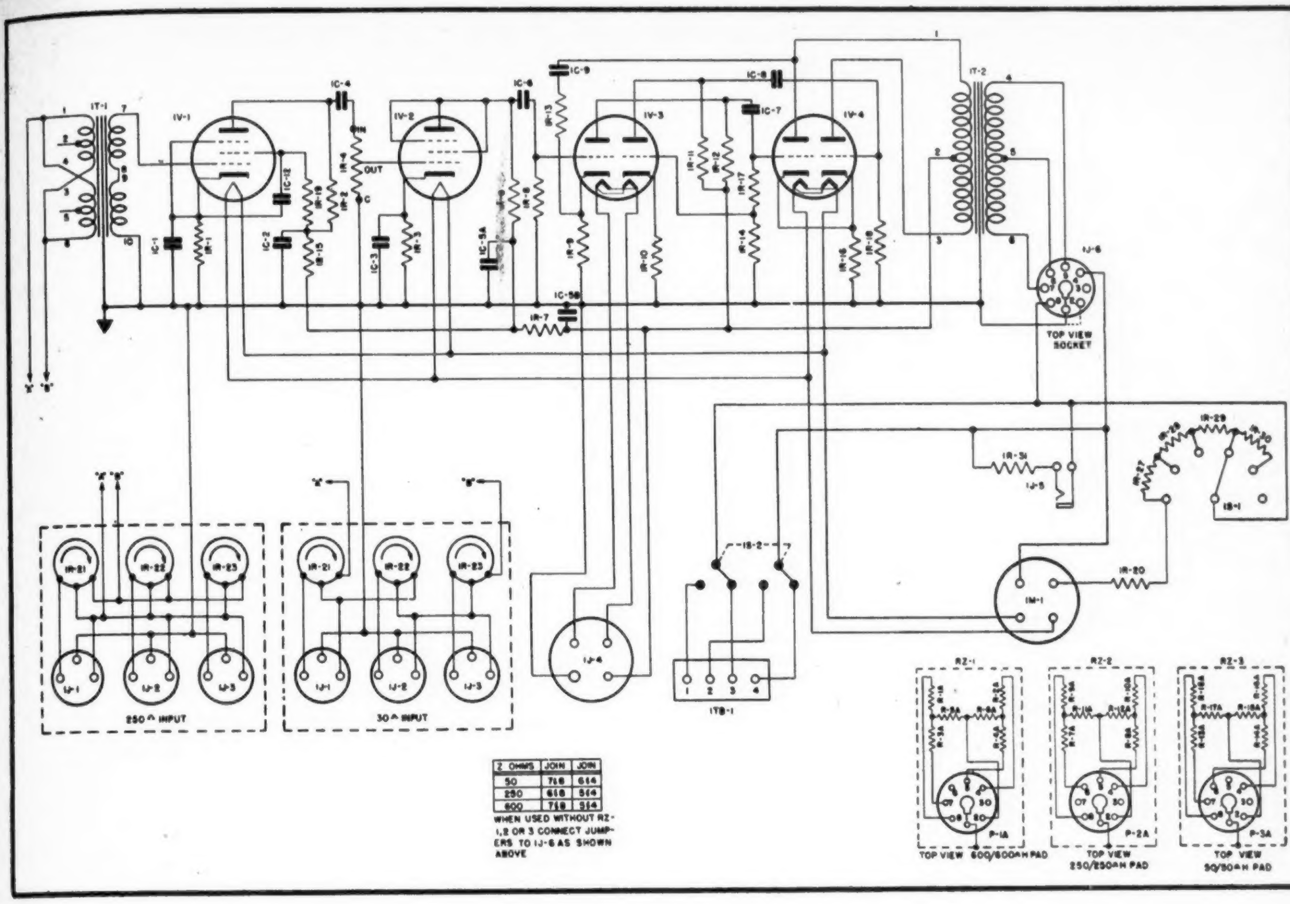
Feedback is incorporated in the line and monitor amplifiers by feeding a portion of the output voltage from the output plate back to the appropriate driver cathode through a resistor-capacitance network.

The frequency response of either the line or monitor amplifier is rated flat within ±2 db from 30 to 15,000 cycles. Distortion is less than 1 per cent from 50 to 15,000 cycles on the line amplifier at an output level of +20 db. The maximum gain of the system from microphone to line is 112 db.



Parts List — Power Supply Unit

C1AB—20-20 μf, 450 v.d.c., working, electrolytic
C2—30 μf, 450 v.d.c., working, electrolytic
F1—2 amp. fuse
I1—6-8 volt pilot bulb
J1—receptacle
L1—choke, 20 h, 50 ma
P2—plug with clamp
R1—25,000 ohms, 10 watts
S1—toggle switch, SPST
T1—power transformer
V1—6X5GT tube
Fuseholder
Pilot assembly, miniature bayonet, red jewel
Socket, black bakelite octal



Parts List — Main Unit

C1, C3—50 μf, 25 v. electrolytic
C2—15 μf, 450 v.d.c., working, electrolytic
C4, C6, C7, C8—0.1 μf, 400 v.d.c., working, paper tubular
C5AB—20-20 μf, 450 v.d.c., working
C9—.02 μf, 400 v.d.c., working, paper tubular
C12—0.5 μf, 400 v.d.c., working, paper tubular
J1, J2, J3—panel type receptacle
J4—receptacle
J5—jack #1
J6—octal socket
M1—meter
R1, R3—1500 ohms
R2—22,000 ohms
R4—25,000-ohm potentiometer
R6, R11, R12—82,000 ohms, 1 watt
R7—10,000 ohms, 1 watt
R8, R13—470,000 ohms, ½ watt
R9, R10—2700 ohms, 1 watt
R14—18,000 ohms, ½ watt
R15—47,000 ohms, 1 watt
R16—560 ohms, 1 watt
R17, R18—150,000 ohms, ½ watt
R19—1 megohm, ½ watt
R20—820 ohms, ½ watt
R21, R22, R23—250/250 or 30/30-ohm attenuator
R27—2700 ohms, ½ watt
R28, R29, R30—2400 ohms, ½ watt
R31—10,000 ohms, ½ watt
RZ1—H-pad, 600/600 ohms, 5 db. Consists of: R1A, R2A, R3A, R4A—82 ohms, ½ watt
R5A, R6A—1000 ohms, ½ watt
P1A—octal tube base
RZ2—H-pad, 250/250 ohms, 5 db (optional). Consists of:
R7A, R8A, R9A, R10A—39 ohms, ½ watt
R11A, R12A—390 ohms, ½ watt
P2A—octal tube base
RZ3—H-pad, 50/50 ohms, 5 db (optional). Consists of:
R13A, R14A, R15A, R16A—10 ohms, ½ watt
R17A, R18A—82 ohms, ½ watt
P3A—octal tube base
S1, S2—switches
T1—transformer, mike or line to push-pull grids
T2—transformer, output type, 20,000 ohms, push-pull 6J5 plates to 500-ohm section
TB1—terminal strip
Knob—special finger grip type
Knob—bar type
Plugs
Socket—black bakelite octal
Tube shell

Feedback further lowers the overall noise and hum level of the amplifier to a point where the signal-to-noise ratio at an operating level of +20 db is approximately 60 db. A noise level of this magnitude is not objectionable even when the amplifier is utilized with speakers capable of excellent wide-band response. In addition extraneous noise and operational clicks are virtually eliminated by the use of airplane-type four-way rubber shock mounting of the cabinet itself.

REMOTE PICKUP AMPLIFIER

The three-channel remote amplifier (see *Fig. 4*) is designed to meet the requirements of a portable a-c remote pickup amplifier for modern broadcast application. The equipment is built in two units comprising an amplifier and a separate power supply. A connecting cable is furnished to connect the two units together and separate carrying cases are supplied for each unit. This arrangement provides the broadcaster with convenient field pickup equipment having studio quality performance.

Circuit Details

The amplifier section employs low-level mixing with provision for three separate input channels having a source impedance of 30/250 ohms. All mixer controls are of the ladder-network type assuring quiet operation over long periods of time. The master gain control is a special potentiometer of the "step" type.

The amplifier consists of four resistance-coupled stages as shown in *Fig. 5*, affording a gain of over 86 db which is more than ample for usual applications. The power supply is conventional, and uses a type 6X5GT/G rectifier.

The input stage of the amplifier employs a 6J7 tube. The low level mixer input circuit is connected to this stage by means of a transformer. The second stage is a voltage amplifier; it also uses a type 6J7 tube, but is connected as a triode. The master gain control for the amplifier is in the grid circuit of this

[*Continued on page* 31]

Calculating the Inductance of Universal-Wound Coils

A. W. SIMON
Director of Research, Stewart-Warner Corp.

Simplified methods of solving practical universal-wound coil design problems are described

For calculating the inductance of circulator coils of rectangular cross-section the formulas of Stefan and Wheeler[1] are available.

These formulas presuppose that the height *c*, the width *b*, the mean radius *a*, and the number of turns *t*, of the coil are already known. But the radio engineer is usually confronted with the converse problem, namely to determine the physical constants of a coil, particularly the number of turns, required to produce a given inductance. Of course, this problem could be solved by trial and error, by assuming various sets of values of the constants *a*, *b*, *c*, and *t*, and calculating the corresponding inductances. However, this process would be laborious and, furthermore, the number of turns corresponding to a given coil cross-section usually cannot be calculated accurately.

In the latter respect the universal-wound coil is an exception, because it has the unique property that the number of turns per layer is the same for every layer, and, furthermore, is a simple function of the gear ratio employed in winding the coil. The proper gear ratio itself, for a given width of coil, dowel diameter, and wire size, can be calculated.[2] Thus, for any assumed number of turns, the height and mean radius of the coil are calculable.[3] In particular, then, in the case of a universal wound coil, given the width of the coil (cam throw), the dowel diameter, wire diameter, and an assumed number of turns, all four of the constants required by the Stefan and Wheeler formulas are determined and calculable. Furthermore, if the resulting inductance is not that desired, the (assumed) number of turns can be corrected by means of the formula previously given by the author.[4] It is not necessary, therefore, to assume usually more than one or two sets of values of the coil parameters in order to determine the proper combination.

Table of Symbols and Formulas Used in Universal Coil Inductance Calculations

- a Mean radius of the coil
- b Axial width of the coil
- c Radial thickness (height above form) of the coil.
- d Dowel diameter
- n Approximate or integral number of crossovers per turn of the dowel
- q Number of crossovers per winding cycle
- s Spacing between centers of adjacent wires on the dowel
- t (Assumed) total number of turns
- t_c Corrected number of turns
- t_1 Number of turns per layer
- w Overall diameter of the wire
- L_c Calculated inductance in microhenries
- L Desired inductance in microhenries
- T_d Number of teeth in the drive gear
- T_c Number of teeth in the cam gear

(1) Calculation of the gear ratio

$$T_c/T_d = (2/n)(1\pm\sqrt{\alpha^2+\beta^2}+\alpha^2) \quad (1)$$

$\alpha = s/qb \qquad \beta = ns/q\pi d \qquad s = 1.25\,w$

(2) Calculation of the turns per layer

$$t_1 = \pm\, nT_c/q(2T_d - nT_c) \quad (2)$$

(3) Calculation of the radial thickness

$$c = tw/t_1 \quad (3)$$

(4) Calculation of the mean radius

$$a = (c+d)/2 \quad (4)$$

(5) Calculation of the Inductance (Wheeler Formula)

$$L_c = 0.8\, a^2t^2/(6a+9b+10c) \quad (5)$$

(6) Calculation of Corrected Turns

$$t_c = t\sqrt{L/L_c} \quad (6)$$

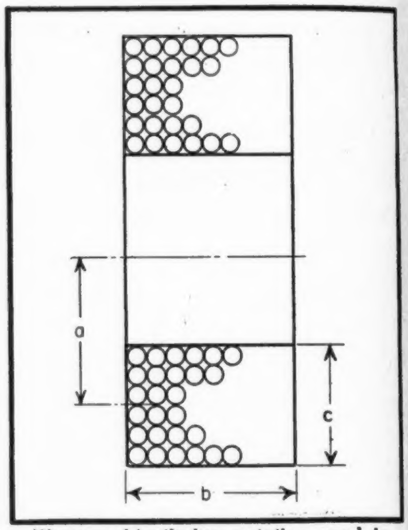


Diagram identifying notation used in equations and text

Hence the problem of finding the number of turns required to produce a desired inductance in the case of a universal coil reduces to the following steps:

(1) Assume a dowel diameter, coil width, wire diameter and number of turns.

(2) Calculate the required gear ratio. (In practice usually one or more of the factors required under (1) and (2), except the number of turns, will already be known.)

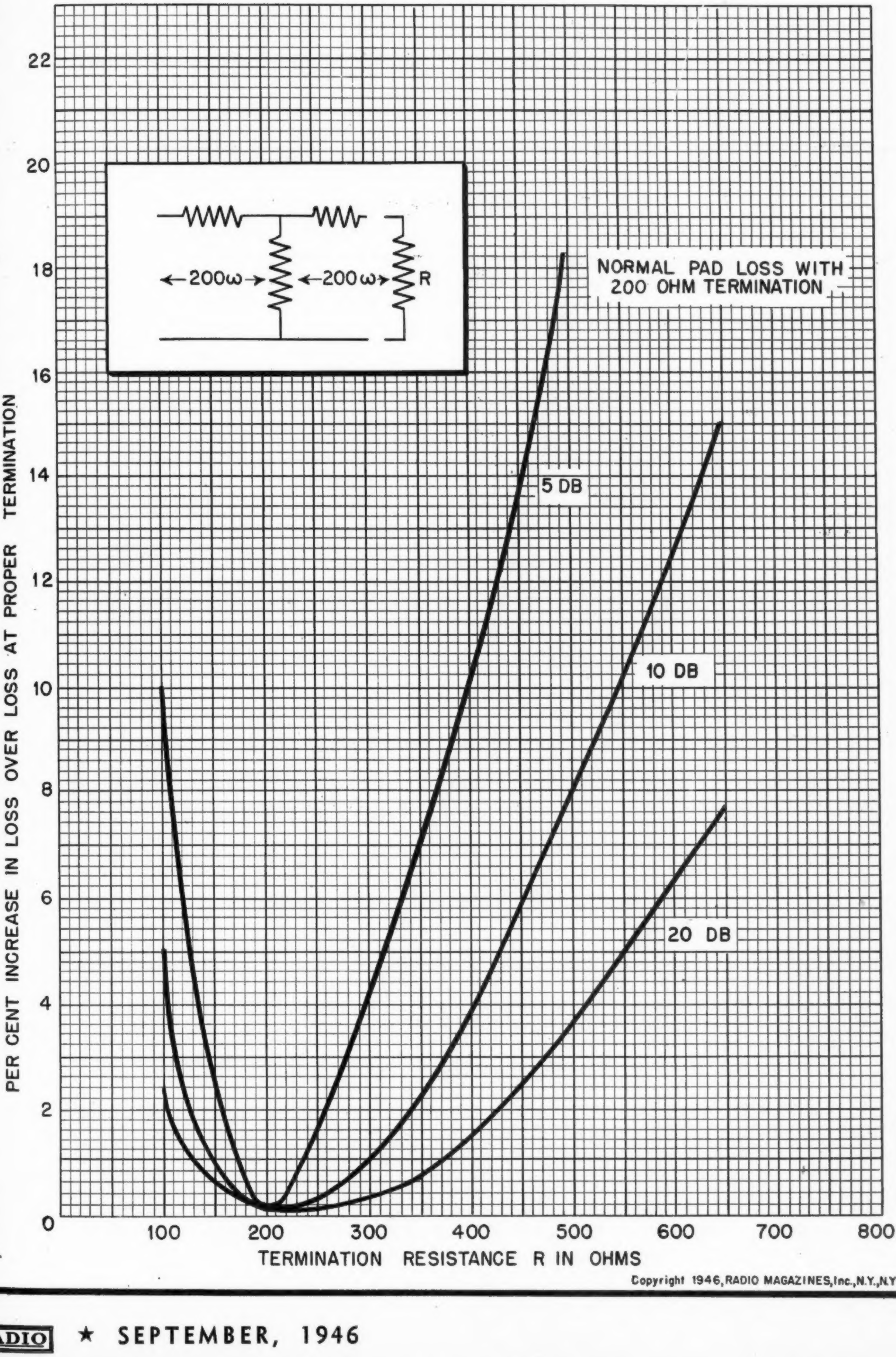
(3) Calculate the number of turns per layer.

[*Continued on page 30*]

Table 1

Cam 3/16	Dowel 3/8	#36 S. S. E.	Gears 27/40	Cam 1/8	Dowel 3/8	#36 S. S. E.	Gears 28/27
Turns	*L(calc.)*	*L(meas.)*	*Diff.*	*Turns*	*L(calc.)*	*L(meas.)*	*Diff.*
200	424	431	1.6%	200	510	521	2.1%
300	994	1002	0.8%	300	1189	1226	3.0%
400	1836	1867	1.7%	400	2200	2258	2.6%
500	2983	3017	1.1%	500	3590	3681	2.5%

Increase in Actual Loss Due to Termination Mismatch of Resistance Pad of 200 Ohms



RADIO DESIGN WORKSHEET

NO. 52 — A-C FILAMENT NOISE

Battery operated receivers generally use filament type tubes rather than indirectly heated cathode types. It is often desirable, however, to operate the battery receiver from the alternating current mains. This inevitably gives rise to some a-c hum and in some cases to intermodulation between signal and power supply frequencies. The plate supply filters can usually be made to have sufficient attenuation that the a-c hum introduced in the plate or grid circuit of the tubes is negligible. The noise from the filament supply, however, cannot always be solved simply. It therefore appears worthwhile to investigate the effect of an a-c filament supply first on a filament type triode amplifier and later on multi-electrode filament type tubes. This discusses the triode amplifier.

The a-c noise due to filament supply which appears in the output of a filament type triode may be due to a variety of causes. There are two, however, of paramount importance, namely:

1. The change of potential of the grid and plate of the tube with respect to some point on the filament with time.

2. The non-linearity of the operational characteristic of the triode and its associated circuit.

Fig. 1 represents a filament type triode audio amplifier circuit. For simplicity, assume the filament to be homogeneous. Also assume that the active portion of the filament is symmetrical with respect to the other tube elements.

Let e_1 = signal voltage applied to grid $= C \sin \omega t$

Let e_2 = filament supply voltage $= A \sin pt$

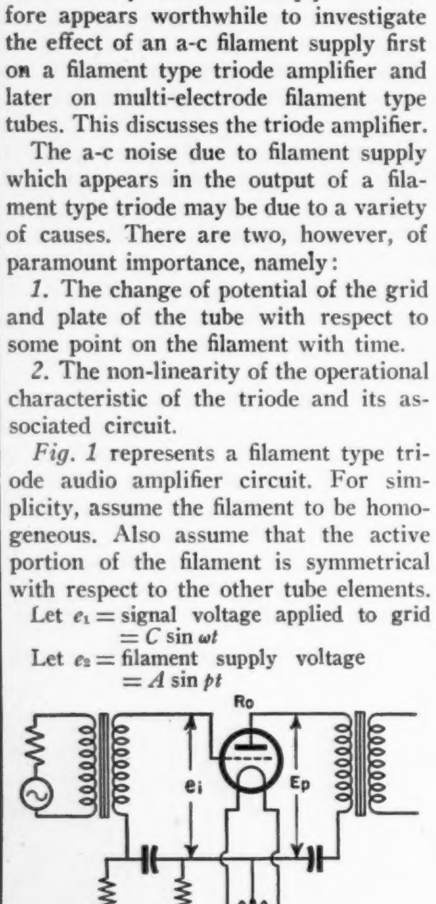


Figure 1

Let E_1 = effective plate voltage

$$= \frac{E_b}{\mu} + K$$

Assume the tube characteristic is represented by a power series:

$$I = \beta_1 e + \beta_2 e^2 + \beta_3 e^3 + \beta_4 e^4 + \ldots\ldots + \beta_n e^n$$

Fig. 2 represents the filament circuit, shown here as a straight line although it may be a *V* or *W* form without appreciably affecting the argument. The

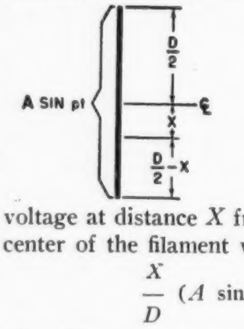


Figure 2

voltage at distance X from the electrical center of the filament will be:

$$\frac{X}{D}(A \sin pt)$$

The differential plate current for differential dX of the filament will be:

$$dI = K\left[E_1 + C \operatorname{Sin} \omega t - \frac{X}{L} A \operatorname{Sin} pt\right]^n dx$$

And:

$$I = K\left[E_1 + C \operatorname{Sin} \omega t\right]^n \int_{-D/2}^{+D/2} \left(1 - \frac{XA \operatorname{Sin} pt}{D(E_1 + C \operatorname{Sin} \omega t)}\right)^n dx$$

Let:

$$E_1 + C \operatorname{Sin} \omega t = E$$

And we have:

$$I = KE^n \int_{-D/2}^{+D/2} \left[1 - N\frac{X}{DE} \operatorname{Sin} pt + \frac{n(n-1)}{2}\frac{A^2X^2}{D^2E^2} \operatorname{Sin}^2 pt + \ldots\right] dx$$

Integrating this expression yields:

$$I = KE^n \left[X - \frac{nA}{DE}\ \frac{x^2}{2} \operatorname{Sin} pt + \frac{n(n-1)}{2}\frac{A^2X^2}{3D^2E^2} \operatorname{Sin}^2 pt \ldots\right]_{-D/2}^{+D/2}$$

Let $KD = \alpha$ which is a tube constant

Whence:

$$I = \alpha\left[E^n + \frac{n(n-1)}{48}A^2E^{(n-2)} + \frac{n(n-1)(n-2)(n-3)}{5120}A^4E^{(n-4)} + \ldots\right]$$

$$+ \alpha\left[\frac{n(n-1)}{48} + \frac{n(n-1)(n-2)(n-3)}{3840}A^4E^{(n-4)} + \ldots\right] \operatorname{Cos} 2pt + \ldots$$

Replace E with $E_1 + C \operatorname{Sin} \omega t$ and neglecting very small terms

$$I = \alpha\left[E_1^n + (A^2 + 12C^2)\frac{n(n-1)}{48}E_1^{(n-2)} + \ldots\right]$$

$$+ \alpha\left[nCE_1^{(n-1)} + \frac{C(A^2 + 6C^2)n(n-1)(n-2)}{48}E^{(n-3)}\right.$$

$$\left.+ \frac{n(n-1)(n-2)(n-3)}{192}A^2C^2E_1^{(n-4)} + \ldots\right] \operatorname{Cos} 2\omega t$$

$$- \alpha\left[\frac{n(n-1)}{48}A^2E_1^{(n-2)} + \frac{A^2C^2}{192} + \frac{A^4}{3840}n(n-1)(n-2)(n-3)E_1^{(n-4)} + \ldots\right] \operatorname{Cos} 2pt$$

$$- \alpha\left[\frac{n(n-1)(n-2)}{96}A^2CE^{(n-3)} + \ldots\right] \operatorname{Sin}(\omega - 2p)t + \ldots$$

These formulae omit a long series of higher order harmonics and higher order modulation products. *Fig. 3* is a table showing the relative amounts of output noise for several values of *N*, which is the exponent of the tube characteristic. Thus if that portion of the operating characteristic over which the tube is operated is linear:

N	1	2	3
DIRECT CURRENT	αE_1	$\alpha\left[E_1^2 + \frac{A^2 + 12C^2}{24}\right]$	$\alpha\left[E_1^3 + \frac{A^2 + 12C^2}{8}E_1\right]$
SIN ωt	αC	$2\alpha CE_1$	$\alpha\left[3CE_1^2 + \frac{A^2C + 6C^3}{8}\right]$
COS $2\omega t$	—	$\frac{\alpha C^2}{2}$	$\frac{3\alpha C^2E_1}{2}$
SIN $3\omega t$	—	—	$\frac{\alpha C^3}{4}$
COS $2pt$	—	$\frac{A^2}{24}\alpha$	$\frac{A^2E_1\alpha}{8}$
SIN $(\omega - 2p)t$	—	—	$\frac{\alpha A^2C}{16}$

Figure 3

$$N = 1$$

Such a circuit adds no noise or modulation products to the output due to filament ripple or alternatiing voltage. If that part of the operational characteristic over which the tube is operated is parabolic, then:

$$N = 2$$

In this case of a square law characteristic, a second and other even order harmonics of the filament supply appears in the output. However, no intermodulation with the signal results. It is pertinent that the coefficient of the second harmonic of the filament supply has a term involving the square of the amplitude of the signal voltage.

If the circuit characteristic requires a cubic term for its mathematical expression:

$$N = 3$$

then intermodulation between signal and filament supply voltages appear in the output as well as all harmonics. It is interesting to note that if instead of a.c. applied to the filament, a direct current involving ripple or other noise will yield identical results if a center tap is used. This is particularly important in equipment used for mobile application such as auto receiver, marine, police, fire, and aviation equipment.

This Month

FCC APPROVES METER

Official engineering approval of an FTR field intensity meter has been given by the FCC, according to an announcement made by Norman E. Wunderlich, executive sales director, Federal Telephone and Radio Corp., Newark, N. J., manufacturers of the equipment. This is understood to be the first time that the FCC has extended approval to such equipment, regardless of manufacture.

As the result of the FCC action, it is no longer necessary to have the meter calibrated by the U. S. Bureau of Standards, and field measurements made by this meter submitted to the Commission will be considered as official as if it had been calibrated by the Standards Bureau.

DENIES MOTOROLA SALE

Recently rumors were rife to the effect that Paul V. Galvin was giving up active management of the Galvin Manufacturing Corp., makers of Motorola home and car radio. In the following statement to RADIO Mr. Galvin makes denial of this rumor.

"My attention has been called to a trade rumor that I, personally, am selling out my interest in the Galvin Manufacturing Corp. and giving up my active management of the concern. There is absolutely no foundation for this rumor. I have no intention of selling my interests and am not even discussing the matter of sale with anyone. Nor do I have any idea of giving up active management of the affairs of the Galvin corporation."

FACSIMILE FOR DETROIT

Facsimile transmission, temporarily discontinued during the war, soon will be resumed again in the metropolitan area of Detroit, Michigan, according to an announcement made by W. J. Scripps, radio director of the Detroit News.

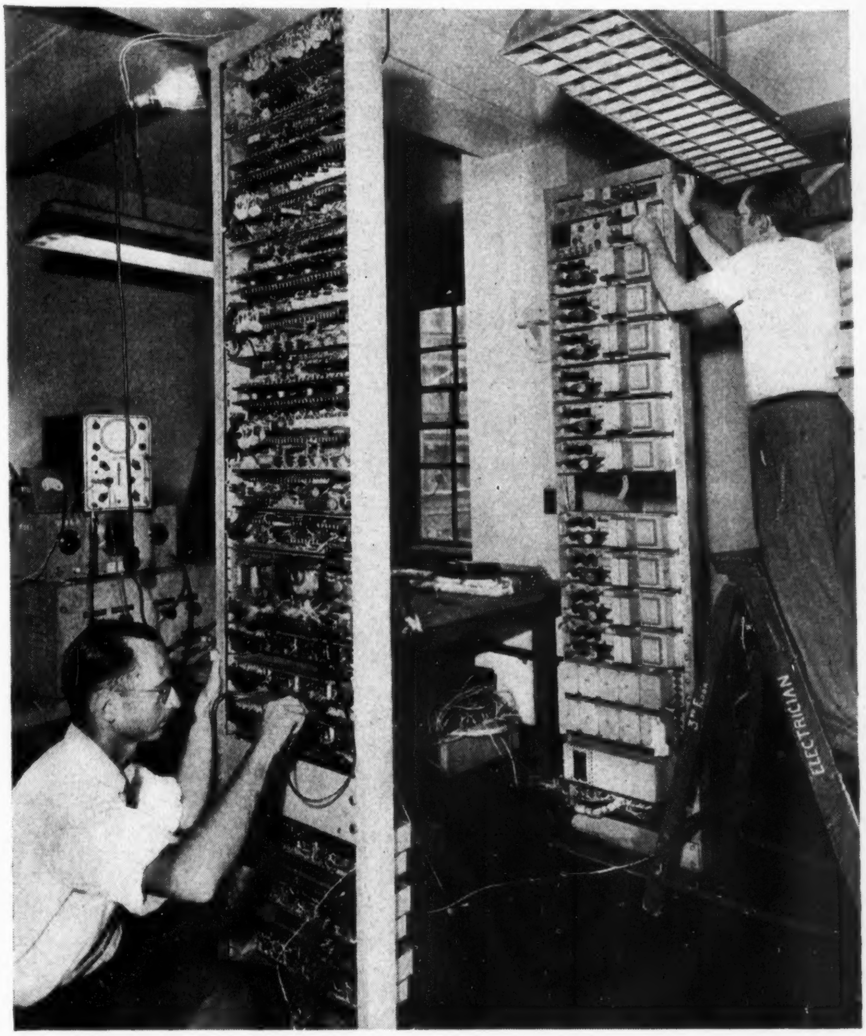
The Detroit News FM transmitter WENA, now in operation, will place its facsimile recorders in homes and other strategic locations in the Detroit area, just as soon as delivery of equipment can be made.

Mr. Scripps, of the Detroit News, said that his AM station WWJ, was one of the pioneer facsimile broadcasting stations prior to the war and, using Finch equipment, was broadcasting experimental facsimile newspapers to the home.

ELECTRONIC EXPOSITION

The $4,000,000,000 electronics industry, that grew out of the 1905 Edison effect experiments, will have its own exposition in New York at the Grand Central Palace from October 14th to 19th. The exposition has an advisory committee, including Dr. Lee De Forest, Robert A. Millikan, E. F. W. Alexanderson, and other notables.

It is planned to design the exposition under three broad categories—communications, broadcasting, and industrial applications. Under communications, the exhibits will be displayed under the groupings of aviation, marine and industrial categories. Under broadcasting there will be subdivisions in AM and FM radio, television, and facsimile. The third major group, that of the industrial application of electronics, will show the equipment used in industry, medicine, science, music, crime detection, and basic materials that are used in the manufacture of various equipment, such as plastics, glass, metals, and plywood.



Final testing on the terminal equipment used in the 24-channel pulse time modulated telephone system developed by the laboratories of the Federal Telephone and Radio Corporation. This equipment transforms the audio signal received from the telephone lines into a train of modulated pulses. These pulses are, in turn, transmitted to their destination by a series of u-h-f links.

N.U. EXPANDS

J. J. Clune, sales manager, distributor division, National Union Radio Corp., Newark, New Jersey, announces the addition of radio receiving sets to the company's expanding line of electronic equipment and parts for national distribution.

The G-619, 6 tube a-c/d-c receiver is the first of a series of 5 diversified models soon to be announced. It employs a tuned r-f superheterodyne circuit with broadcast band tuning and full vision slide rule dial scale.

NEW NAME, OLD ADDRESS

Manufacturers Screw Products announce a change in name to Stronghold Screw Products, Inc. Their line of products is unchanged and operations are continuing as usual at 216-222 West Hubbard St., Chicago 10, Ill.

WEST COAST TRADE SHOW

West coast electronics manufacturers have announced plans for the second annual Electronics Trade Show to be held in Los Angeles October 18 20.

Plans are being made for 113 exhibits covering all types of electronic devices manufactured in the west. For the first time since termination of hostilities the electronics marvels which helped bring

[*Continued on page* 26]

New Products

NEW 5" OSCILLOGRAPH

The new Du Mont type 274 cathode-ray oscillograph is announced by the Allen B. Du Mont Laboratories, Inc., of

Passaic, N. J. This instrument answers the long-standing need for a good oscillograph for routine laboratory and production testing.

The linear time-base has a range of 8 to 30,000 c.p.s. Synchronization may be from the vertical amplifier or an external signal. Identical vertical and horizontal amplifiers have a range from 20 to 50,000 c.p.s. There is provision for intensity modulation.

Input impedance: vertical-direct 5 meg. 50 micro-microfarads; vertical amplifier 1 meg. 40 micro-microfarads. Horizontal-direct 5 meg. 60 micro-microfarads; horizontal amplifier 5 meg., 40 micro-microfarads. Frequency range: Sine wave response (at full gain) uniform within plus or minus 20% from 20 to 50,000 cps, down less than 50% at 100,000 cps. Deflection sensitivity: Amplifiers at full gain. 65 rms volt/in; direct, plus or minus 18 rms volts/in.

LABEL DISPENSER

Production operators mark wires much faster it is claimed by using new Quik-Label bench dispenser recently developed by W. H. Brady Company. It is described in an illustrated folder which will be sent gratis, together with free samples of code

cards, by writing the W. H. Brady Company, 2900-R E. Lindwood Ave., Milwaukee 11, Wis.

RURAL RADIO

John Meck Industries, radio and television manufacturer at Plymouth, Ind., has announced that production on its farm model radio is well under way and that several thousand sets have already been manufactured.

Powered entirely on a battery pack, it was designed especially for farmers and others living in rural areas where electricity is not readily available, but where a sensitive set is desired.

Containing five miniature tubes that draw 1.4 volts, and equipped with a five-inch speaker, the superheterodyne chassis is supplied with table model wood cabinet. The set will function on the A battery for 750 continuous hours.

HEAD-PHONE CUSHIONS

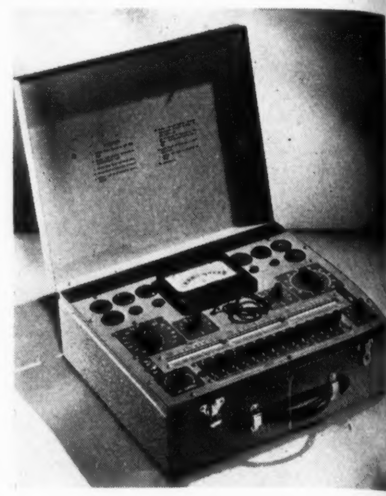
Aviometer Corporation, 370 West 35th New York City, is now manufacturing exclusively a new type air-cooled head-

phone cushion made of molded, heat-conducting rubber. This product brings pilots and other aviation personnel the benefits of a new development in synthetic rubber manufacture.

TUBE TESTERS

Two new electron tube testers based on a patented circuit suitable for all standard receiving and several special types of tubes have been announced by R. W. Andrews, merchandise manager, Radio Tube Division, Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y. The new testers, he said, combine many developments for production tube testing and provide approximately 80% of available accuracy in commercial tube production equipment.

The new instruments, counter type 139 and portable type 140, provide accurate tube testing facility for shop, spot testing in the home, industrial electronic applications, automobile and mobile radio equipments. Accurate checks of receiving type tubes used in broadcast receivers, FM, television, industrial electronic controls, record players and photoelectric devices



may be made under dynamic conditions and without damage to tubes.

Design of the testers includes extra sockets and switch contacts for modernization as new tube types are developed. Test for shorts may be made without danger of grid-filament contacts due to electrostatic attraction in battery type tubes where spacing between these elements is close. Provision is also made for noise testing.

Both instruments are supplied for 105-125 volts, 50-60 cycle a-c operation and are rated at 20 watts. Controls are readily accessible and all markings, including those on the 4½" meter face are easily read.

CABLE DISPENSER

A new method of packaging dial cord is announced by the JFD Mfg. Co., 4117 Fort Hamilton Parkway, Brooklyn 19, New York. Cables and cord come wound on a metal spool and are housed in an unbreakable glassine container. The all-metal spool prevents the cable from unraveling, kinking or tangling.

CLEAT-MOUNTING ELECTROLYTIC

A universal or general-purpose cleat-mounting electrolytic capacitor, heretofore offered only in a cardboard-tube case, is now made available in an aluminum can, by Aerovox Corp., New Bedford, Mass.

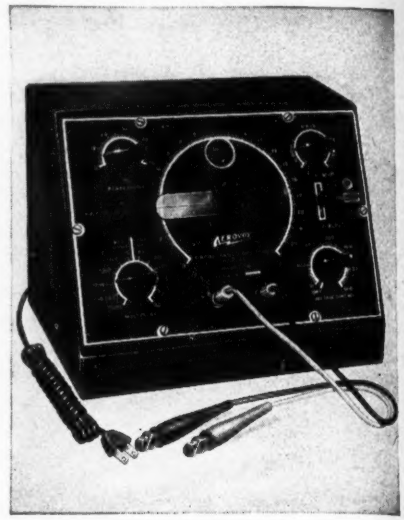
To install, the center screw is removed, metal cleat slipped off, wire leads passed through mounting hole, and the metal

cleat and screw then replaced from the underside of the chassis and tightly drawn up, thereby mounting the unit rigidly in place.

RESISTANCE-CAPACITANCE BRIDGE

The Model 76 Resistance-Capacitance Bridge is a new postwar general-utility instrument combining simplicity of operation, remarkable degree of accuracy, and modest price, just announced by Aerovox Corp. of New Bedford, Mass.

For maximum sensitivity and accuracy both resistance and capacitance readings



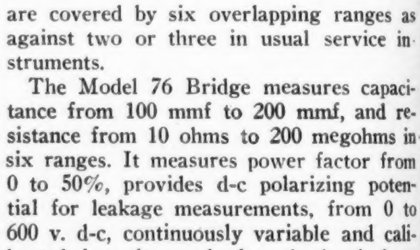
are covered by six overlapping ranges as against two or three in usual service instruments.

The Model 76 Bridge measures capacitance from 100 mmf to 200 mmf, and resistance from 10 ohms to 200 megohms in six ranges. It measures power factor from 0 to 50%, provides d-c polarizing potential for leakage measurements, from 0 to 600 v. d-c, continuously variable and calibrated in volts, and also checks leakage of electrolytic capacitors or insulation resistance of paper or mica capacitors.

COLOR CODE GUIDE

Allied Radio Corp. announces the release of their new RMA-JAN color code guide for radio resistors.

Three rotary discs are provided for setting the code colors and corresponding resistance values which are brought into alignment automatically. Code colors may be set to show corresponding resistance values, or resistance values may be set to show corresponding code colors. The guide includes data covering resistance tolerance.



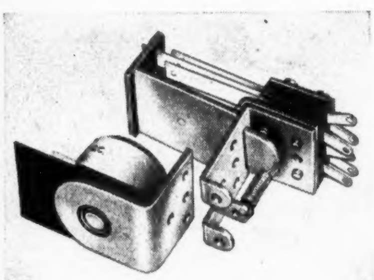
TEN AMPERE VARIAC

Designed to fill the gap between the conventional 5-amp. and 20-amp. adjustable auto-transformers, General Radio Co. announces a new Type V-10 Variac. The 115-v. models are rated at 10 amps., with a 15-amp. maximum.

Output voltage is continuously variable from 0 to 17% above line voltage. The improved brush construction of Type V-5 is used in the new Variac. Models are also available for 220-v. service.

NEW RELAYS

A 4-page bulletin describes the new series-200 Guardian relay with interchangeable coil and contact assemblies; also kit of series-200 switch parts. Complete assortment consists of four coils in 6, 12, 24 and 115 volts a.c. and five coils in 6, 12, 24, 32 and 110 volts d.c., each interchangeable with one single-pole double-throw and one double-throw double-pole contact assembly. A parts kit permits extra contact combinations up to four-pole double-throw which are also interchangeable with the nine coils. Write Guardian Electric Mfg. Co., 1605 West Walnut St., Chicago 12, Ill.



MONITOR AMPLIFIER

A new two-stage, medium-gain, 15-watt power amplifier for use as a monitor amplifier or sound reinforcement amplifier is announced by Pan American Co., 132 Front St., New York City. From a 600-ohm source the gain is approximately 50 db.

The amplifier is intended to operate normally from a 600-ohm source impedance and has a high-impedance connection to accommodate 20,000 ohms. The unit works into output impedances from 500 to ∞ ohms. Approximate output noise level is 70 db below 42 VU. Frequency characteristic, 0 to -1 db from 40 to 10,000 cps. Maximum power consumption is 150 watts.

THIS MONTH

[*from page 21*]

about victory will be shown together with postwar developments made possible by unusual war time experiments

Sponsored by the West Coast Electronics Manufacturers Association the trade show will be presented by the industry's committee which includes Ed Grigsby, chairman; D. F. MacLachlan, and Russell Dietrich, all of Los Angeles, and Les Logan of San Francisco. Officers of the association are L. W. Howard of Los Angeles, president; Ralph Shermund, vice president; H. O. Brown, secretary, both of San Francisco, and J. L. Fouch of Los Angeles, treasurer. A. H. Gudie of Los Angeles is executive secretary.

N.E.C. SLATED

Electronic physicists, engineers, designers, production men and others engaged in the electronic industry will be interested in the comprehensive program planned for the 1946 National Electronics Conference to be held at the Edgewater Beach Hotel, Oct. 3, 4 and 5.

Every effort has been made to develop a program of outstanding technical excellence with papers presented by authorities in their respective fields. Several sessions will run concurrently, but the program has been planned to minimize, if not eliminate, overlapping of papers on related topics.

NEW APPOINTMENTS

Walter M. Norton

★ Appointment of Walter M. Norton as President of the RCA Victor Distributing Corporation has been announced by Frank F. Folsom, Executive Vice President in charge of the RCA Victor Division. Mr. Norton will continue as director of the recently organized Distribution Department of RCA Victor, the announcement said.

G. C. Connor

★ George C. Connor has been appointed General Sales Manager of the Electronics Division of Sylvania Electric Products, Inc., according to an announcement made here today by Robert H. Bishop, Director of Sales for the company.

George C. Connor

R. O. Curry

★ Dr. R. O. Curry, acoustical expert, has been appointed audio and acoustical engineer for Farnsworth Television & Radio Corp., Fort Wayne, Ind., according to B. R. Cummings, Vice-President in Charge of Engineering. He previously was audio research head for the Capehart Division of Farnsworth.

L. B. Keim

★ The Daven Company of 191 Central Ave., Newark, N. J., announces the appointment of Llewellyn Bates Keim as Field Electronics Engineer.

Llewellyn Bates Keim

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Fritz Franke

★ Fritz Franke, assistant to the sales manager of the Hallicrafters Company of Chicago, producers of high frequency radio equipment, has been reappointed chairman of the marine section, transmitter division of the Radio Manufacturers Association.

T. K. Burgenbauch

★ Theodore K. Burgenbauch has been appointed Electronics Division Production Manager by H. Ray Ellinwood, president of Ellinwood Industries, Los Angeles.

Winfield Wagener

★ Winfield Wagener has recently been appointed to the sales engineering staff at Eitel-McCullough, Inc., San Bruno, California, manufacturers of radio transmitting tubes. After receiving his M.S. degree from the University of California, he worked for RCA, and later was appointed chief engineer for Heintz & Kaufman in charge of all tube development and design. In 1944 he went to the Litton Engineering Laboratories as head of the tube division, where he conducted research and development in tubes for "radar countermeasures". Also a former chairman of the San Francisco section of I.R.E., he has written many articles on tube design for technical magazines.

Arthur E. Newlon

★ Arthur E. Newlon, senior engineer in the Stromberg-Carlson Company's research department, was recently elected chairman of the Rochester section, Institute of Radio Engineers.

Mr. Newlon, who is a senior member of the IRE, was graduated from Ohio State in 1933. A member of Tau Beta Pi, Eta Kappa Nu, and an associate member of Sigma Xi, he worked on the company's development of radar facilities during the war. Recently he has been engaged in television development.

William J. Nezerka

★ Renald P. Evans, President of The Turner Company, Cedar Rapids, Iowa, announced recently that William J. Nezerka has been named Vice President and Sales Manager of the Turner firm and elected to the Board of Directors. Nezerka has been Sales Manager of The Turner Company, manufacturers of microphones and electronic devices.

William J. Nezerka

William H. Myers

★ Appointment of William H. Myers as Chief Engineer of the Receiver Division, Farnsworth Television & Radio Corporation, has been announced by B. R. Cummings, Farnsworth Vice President in charge of Engineering.

William H. Meyers

Mr. Myers succeeds J. H. Pressley, who has been retained as a consultant to the company.

FTR APPOINTS WENDELL

Edward N. Wendell, who has been associated with the International Telephone and Telegraph Corp. system since 1925, has been appointed vice president in charge of the Federal Telephone and Radio Corp., domestic manunfacturing affiliate of I. T. & T., it was announced today. Mr. Wendell in his new post assumes full managerial authority of FTR, which last year produced in excess of $80,000,000 of telephone, radio and electronic equipment for the Armed Forces and civilian use.

LEAR APPOINTMENTS

Following a recent reorganization of its engineering activities, appointment of new chief engineers for the three internal divisions of Lear, Inc., Grand Rapids, Mich., are announced by William P. Lear, president.

Harry E. Rice now becomes chief engineer of the Lear Home and Aircraft Radio Division. Harry S. Jones is new chief engineer in charge of research and development. William J. Perfield will head engineering activities of the Lear electro-mechanical division.

SQUELCH CIRCUITS

[*from page* 13]

Single-tube squelch circuits are likewise used in domestic receivers, such as the Emerson 678 auto radio, as shown in *Fig. 8.* In this receiver a 6B7 operates as a detector, squelch, and a-v-c tube, in addition to amplifying at i-f and a-f frequencies.

Squelch circuits find widest application in specialized services where operation is intermittent, with extended stand-by periods. These include rail-

road, police and other mobile service, airport, and forest-service installations.

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Electronic Engineering Master Index
Marconi Co. Patent File

Universal-Wound Coils

[*from page* 18]

(4) From the total number of turns assumed, the computed number of turns per layer, and the overall diameter of the wire, calculate the height of the coil.

(5) From the height of the coil and the dowel diameter calculate the mean radius.

(6) Insert the values so found in either the Stefan or Wheeler formula to find the corresponding inductance.

(7) If the calculated inductance is not that desired, correct the number of turns by means of the formula previously given by the author.

(8) If necessary repeat the process using the corrected number of turns found under (7).

Experimental Test

In order to test how accurately the inductances of universal wound coils could be calculated, the inductances corresponding to various numbers of turns were calculated on the basis of the Wheeler formula for two combinations and compared with the measured inductances (*Table 1*).

It will be seen from these figures that the agreement between the calculated and measured values is very good; in fact, well within the usual 3% tolerance allowed in coil manufacture.

Example Using Wheeler Formula

(1) and (2) Let it be desired to calculate the number of turns required to produce a coil with an inductance of 4.00 mh, using a ¼" cam ($b = 0.250''$); a ⅜" dowel ($d = 0.375''$); #36 S.S.E. wire ($w = 0.0071''$); and a gear ratio of 27/53 ($T_a = 27$, $T_e = 53$), which corresponds to 1 crossover per turn ($n = 1$) and 2 crossovers per winding

cycle ($q=2$). Assume 600 turns ($t=600$).

(3) The number of turns per layer for a gear ratio of 27/53 is

$$t_1 = 53/2\ (54-53) = 26.5$$

(4) The height c of the coil corresponding to 600 turns is

$$c = 600 \times .0071''/26.5 = 0.161''$$

(5) The mean radius according to Eq. (4) is

$$a = 0.1875'' + 0.0805'' = 0.268''$$

(6) Since b was already given as 0.250″ under (1), we now have all the constants required by the Wheeler formula (Eq. 5). In particular, $6a=1.608''$, $9b=2.250''$, and $10c=1.610$. Accordingly the inductance corresponding to 600 turns is

$$L = 0.8\ (.268 \times 600)^2/5.468 = 3.78 \text{ mh}$$

(7) Since the resulting inductance is not exactly that desired, we correct the number of turns according to the equation:

$$t = 600\sqrt{4.00/3.78} = 617 \text{ turns}$$

that is, 617 turns are requared to produce 4.00 mh.

References

[1]"Simple Inductance Formula for Radio Coils—H. A. Wheeler—*Proc. I. R. E.*, Oct. 1928.

[2]*Proc. I. R. E.*, vol. 33, pp 35-37, Jan. 1945.

[3]*Electronics*, vol. 34, p 162, Mar. 1946.

[4]*Electronics*, vol. 18, p 170, Nov. 1945.

[5]"The Design of Universal Winding—L. M. Hershey—*Proc. I. R. E.*, Aug. 1941.

Speech Input Equipment

[*from page* 17]

stage. The third stage utilizes a type 6SN7GT tube as a self-balancing phase inverter. The fourth tube is a type 6SN7GT operating as a push-pull output stage and it is connected through a transformer to feed 600, 500, 250 or 50 ohm output impedance lines. Feedback is incorporated by feeding a portion of the output voltage from one output plate to the appropriate phase inverter cathode.

The amplifier is arranged so that various values of fixed H-pad attenuators may be inserted in the output as desired. Normally a 5-db pad of 600/600 ohms impedance is supplied; however, 250/250 or 50/50 ohm impedance pads are available. These pads may be balanced to ground by adding a simple connection if desired. Direct output can be had by arranging a dummy plug with jumpers. The output of the amplifier is connected to the "Output" switch on the front panel. This switch selects either of two lines as desired.

The volume level indicator is of the approved type and has internal illumination. The meter switch is provided with the following settings: 1 mw, +4, +6, +8, +10 VU and Off. All of these settings except "Off" correspond to the 100 mark on the meter scale.

Specifications

The electrical characteristics of the amplifier are such that the fidelity is flat within 1 db from 30 to 15,000 cycles. With a —60 db input and +16 db output, the noise level is —65 db. These figures are based on a reference level of 1 mw.

The gain of the amplifier from the microphone input to the output terminal is 86 db, measured with a 5-db pad in the output circuit. Without this pad the gain is approximately 91 db. The distortion of the unit at 316 mw output is less than 1 per cent; with 50 mw output the distortion is less than 0.5 of 1 per cent.

The power supply of the unit is conventional and furnishes 250 volts d-c at 25 ma. It also provides current for the operation of the filaments in the amplifier. The ripple voltage of the power supply is 0.0098 volts.

Mechanical features, making this amplifier adaptable for modern broadcast use, are many. In the cabinet construction, for example, sloping panels are employed — the cabinet is of 16-gage steel and ribbed where necessary for added strength. Knobs of standard studio design make for ease of operation and a convenient type of handle is employed for carrying which lays flat when not in use.

ADVERTISING INDEX

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Microphone Cables

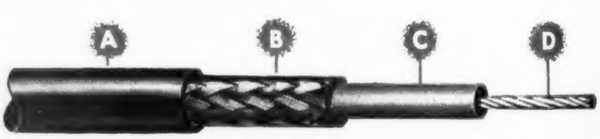
Low Capacitance • Flexible Plastic Jackets

Amphenol engineers announce a new line of four microphone cables in three sizes and two kinds of plastic jackets. All are of unusually low capacitance for their small diameter. They are designed for use by P.A. system installers and service men and for manufacturers of sound equipment, photoelectric devices, home recorders and the complete range of similar applications—as well as for regular studio type installations.

These cables are small in diameter, light in weight and the durable plastic jackets remain flexible down to —40°. Standard microphone connectors and cord protectors may be used with any type. Amphenol cable numbers 21-120, 21-138 and 21-146 have black vinyl jackets. Style 21-147 is the same as 21-138 except it has a polyethylene jacket.

The vinyl type jacket is recommended for heavy use in auditoriums, outdoors and other places where long lengths are required and where crowds of people may be walking over the cable. Polyethylene (21-147) is suitable for home and cocktail lounge applications, where the cord may remain in one position for many days, because the material is chemically inert and has no effect on varnishes. See table below for complete electrical and physical specifications.

	21-120	21-138	21-146	21-147
A	.242" diam. Black Vinyl	.195" diam. Black Vinyl	.155" diam. Black Vinyl	.195" diam. Black Polyethylene
B	#34 AWG. COPPER 65% COVERAGE	#34 TINNED COPPER 65% COVERAGE	#36 TINNED COPPER 65% COVERAGE	#34 TINNED COPPER 65% COVERAGE
C	POLYETHYLENE .175" diam.	POLYETHYLENE .116" diam.	POLYETHYLENE .080" diam.	POLYETHYLENE .116" diam.
D	7 STRANDS #30 WIRE	7 STRANDS #30 WIRE	7 STRANDS #30 WIRE	7 STRANDS #30 WIRE
CAPACITANCE PER FOOT	20 mmf	25 mmf	35 mmf	25 mmf



Microphone Connectors

Amphenol manufactures a complete line of microphone connectors, receptacles and jacks. Connectors are available in straight, right angle and feed-through styles. Receptacles are of single hole and mounting plate types—grounded or insulated.

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